CERTIFICATE

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[Title of the Invention] LIQUID CRYSTAL PANEL AND METHOD FOR FABRICATING THE SAME

[Claims]

[Claim 1] A liquid crystal panel comprising a pair of rectangular substrates bonded to each other by a sealant with a predetermined gap therebetween, a liquid crystal enclosed in the region delimited by the sealant between the pair of substrates, and electrodes formed on each of the pair of substrates for controlling the alignment state of the liquid crystal,

wherein each of the pair of substrates is provided with an alignment layer formed on the electrode-side surface, the alignment layer being formed up to the region overlapping the region for forming the sealant in the sections corresponding to at least three sides of the substrate provided with the alignment layer.

[Claim 2] The liquid crystal panel according to Claim 1, wherein the sealant is a one-part thermosetting epoxy sealant.

[Claim 3] The liquid crystal panel according to either Claim 1 or 2, wherein the alignment layer is formed up to the region overlapping the region for forming the sealant in the sections corresponding to four sides of the substrate.

[Claim 4] The liquid crystal panel according to any one

of Claims 1 to 3, wherein the alignment layer is formed up to the edges of the substrate across the region for forming the sealant in the individual sides of the substrate excluding the side provided with input-output terminals and terminals for conducting between substrates.

[Claim 5] The liquid crystal panel according to any one of Claims 1 to 4, wherein a transparent insulation film for covering the electrodes on the lower layer side of the alignment layer is formed in the region substantially overlapping the region for forming the alignment layer.

[Claim 6] A method for fabricating the liquid crystal panel defined in any one of Claims 1 to 5 comprising the steps of forming the electrodes on the surface of a large substrate for forming a plurality of pairs of substrates in the individual regions for forming the substrates which are to be divided by cutting the large substrate along cutting projection lines, and then forming thin films for forming the alignment layers up to the regions for overlapping the regions for forming the sealant in the sections corresponding to at least three sides of the regions for forming the substrates.

[Claim 7] The method for fabricating the liquid crystal panel according to Claim 6, wherein, after the electrodes are formed on the surface of the large substrate for forming a plurality of pairs of substrates in the individual regions

for forming the substrates which are to be divided by cutting the large substrate along cutting projection lines, the thin films for forming the alignment layers are formed on a plurality of substrate-forming regions including the cutting projection lines.

[Claim 8] The method for fabricating the liquid crystal panel according to Claim 7, wherein, after the electrodes are formed on the surfaces of a pair of large substrates for forming a plurality of pairs of substrates in the regions for forming the individual substrates which are to be divided by cutting the large substrates along cutting projection lines, the thin films for forming the alignment layers are formed on the plurality of substrate-forming regions including the cutting projection lines in each of the pair of large substrates, the sealant is then disposed on at least one of the pair of large substrates to bond the large substrates to each other, and the bonded large substrates are cut along the cutting projection lines.

[Claim 9] The method for fabricating the liquid crystal panel according to either Claim 7 or 8, wherein, in the large substrate, the substrate-forming regions are placed with a cutting projection line therebetween so that the sides provided with input-output terminals and terminals for conducting between substrates are directed in the opposite directions, and when the thin films for forming the

alignment layers are formed, the thin films are formed in strip along the cutting projection line.

[Detailed Description of the Invention]

[0001]

[Technical Field of the Invention]

The present invention relates to liquid crystal panels used for liquid crystal display devices and methods for fabricating the same. More particularly, the invention relates to fabricating techniques for the individual substrates constituting the liquid crystal panels.

[0002]

[Description of the Related Art]

As shown in Figs. 11(A) and 11(B), a first substrate 1 and a second substrate 2 constituting a liquid crystal panel 10 are bonded to each other by a sealant 3 with spacers 32 therebetween, leaving a predetermined gap. A liquid crystal 40 is enclosed in a gap 31. Polarizers 4A and 4B are attached to the first and second substrates 1 and 2, respectively. On the inner surface of the first substrate 1, electrodes 6A, which are composed of ITO (Indium Tin Oxide) films or the like as transparent conductive films for displaying various characters or for displaying dots, are formed on the surface of an underlayer protective film 11, which is composed of a silicon oxide film or the like; and on the inner surface of the second substrate 2, electrodes

7A composed of ITO films for displaying various characters or for displaying dots are also formed on the surface of an underlayer protective film 21 composed of a silicon oxide film or the like. Transparent insulation films 12 and 22 are formed so as to cover the electrodes 6A and 7A in the first and second substrates 1 and 2, and alignment layers 13 and 23 composed of polyimide films are formed on the surfaces of the transparent insulation films 12 and 22.

[0003]

The sealant 3 conventionally used is composed of a two-part phenol-novolac-type epoxy resin or two-part aliphatic-type epoxy resin, and if the sealant 3 is brought into contact with the alignment layers 13 and 23 composed of polyimide films, sufficient adhesion is not likely to be ensured at the interfaces. Therefore, in the conventional liquid crystal panel 10, a space S must be secured between the sealant 3 and the alignment layer 13 or 23, and the following fabrication method has been used. That is, in the fabrication process of the conventional liquid crystal panel 1, as shown in Fig. 12, firstly, the electrodes 6A and 7A are formed in the regions for forming the individual substrates, which correspond to single first and second substrates 1 and 2, produced by dividing first and second large substrates 1A and 2A which include a plurality of first and second substrates 1 and 2 to be cut out, and which

are obtained by cutting along cutting projection lines L1 and L2 of the large substrates 1A and 2A. The transparent insulation films 12 and 22 are then formed in the regions (the regions marked by slanted broken lines in Fig. 12) that are slightly inside the regions for forming the sealant 4. Next, the alignment layers 13 and 23 (polyimide films) are formed by flexographic printing so as to be superposed on the transparent insulation films 12 and 22. On one of the first and second large substrates 1A and 2A, the sealant 3 is formed so as to surround the regions for forming alignment layers 13 and 23 in the periphery, and the first and second large substrates 1A and 2A are bonded to each other with the sealant 3. Next, after the bonded first and second large substrates 1A and 2A are divided into single panels or into strip panels, a liquid crystal is injected under reduced pressure from an opening 30 of the sealant 3, and the opening 30 of the sealant 3 is then closed.

[0004]

[Problems to be Solved by the Invention]

However, in the conventional liquid crystal panel 1, as shown in Fig. 11(B), since there is the space S between the sealant 3 and the alignment layer 13 or 23, low twist domains are generated in the liquid crystal 40 in the section corresponding to the space S. Since the low twist domains degrade the display quality, such regions cannot be

used as regions for displaying images. Consequently, the effective region for displaying images is narrowed. If the alignment layers 13 and 23 are formed by flexographic printing so as to be brought as close as possible to the region for forming the sealant 3 (the region marked by slanted solid lines in Fig. 12), the regions in which low twist domains occur can be narrowed. However, even if the accuracy of a flexographic printer is increased, it is not possible to control the printing region (the region marked by slanted broken lines in Fig. 12) of the alignment layers 13 and 23 in a roller travelling direction (the direction shown by an arrow X in Fig. 12) so as to reduce the space S in which low twist domains occur. Although, in the width direction of a roller used for flexographic printing (the direction shown by an arrow Y in Fig. 12), the printing region can be more easily controlled in comparison with that in the roller travelling direction, yet it is impossible to narrow the region in which low twist domains occur beyond a certain amount.

[0005]

In view of the problems described above, it is an object of the present invention to provide a liquid crystal panel in which the region for displaying images can be enlarged by preventing low twist domains from occurring in the space region between a sealant and alignment layers.

[0006]

[Means for Solving the Problems]

In order to overcome the problems described above, in the present invention, a liquid crystal panel includes a pair of rectangular substrates bonded to each other by a sealant with a predetermined gap therebetween, a liquid crystal enclosed in the region delimited by the sealant between the pair of substrates, and electrodes formed on each of the pair of substrates for controlling the alignment state of the liquid crystal. Each of the pair of substrates is provided with an alignment layer formed on the electrode-side surface, the alignment layer being formed up to the region overlapping the region for forming the sealant in the sections corresponding to at least three sides of the substrate provided with the alignment layer.

[0007]

In accordance with the present invention, since the alignment layer is formed up to the region overlapping the region for forming the sealant, there is no space between the sealant and the alignment layer. Therefore, there is no possibility that low twist domains occur in the vicinity of the inner periphery of the sealant. Thus, since the vicinity of the inner periphery of the sealant can also be effectively used as the region for displaying images, the region for displaying images can be enlarged.

[0008]

In the liquid crystal panel of the present invention, the sealant may be a one-part thermosetting epoxy sealant having good adhesion to a polyimide film used as the alignment layer.

[0009]

In accordance with the present invention, since the one-part thermosetting epoxy sealant has good adhesion to the polyimide film used as the alignment layer, and in particular, since a one-part thermosetting epoxy sealant containing a high-impact epoxy, in which an acrylic or silicone rubber is graft-polymerized to an epoxy resin, has excellent adhesion to the polyimide film, even if the sealant is disposed so as to overlap the surface of the alignment layer, satisfactory water-tightness and airtightness can be ensured at the interface.

[0010]

In the liquid crystal panel of the present invention, the alignment layer may be formed up to the region overlapping the region for forming the sealant in the sections corresponding to four sides of the substrate.

[0011]

In the liquid crystal panel of the present invention, the alignment layer may be formed up to the edges of the substrate across the region for forming the sealant in the

individual sides of the substrate excluding the side provided with input-output terminals and terminals for conducting between substrates among the four sides of the substrate.

[0012]

In the liquid crystal panel of the present invention, a transparent insulation film for covering the electrodes on the lower layer side of the alignment layer may be formed in the region substantially overlapping the region for forming the alignment layer.

[0013]

In the present invention, a method for fabricating the liquid crystal panel includes the steps of forming the electrodes on the surface of a large substrate for forming a plurality of pairs of substrates in the individual regions for forming the substrates which are to be divided by cutting the large substrate along cutting projection lines, and then forming thin films for forming the alignment layers up to the regions for overlapping the regions for forming the sealant at least in the sections corresponding to three sides of the regions for forming the substrates.

[0014]

In the method for fabricating the liquid crystal panel in accordance with the present invention, preferably, after the electrodes are formed on the surface of the large

substrate for forming a plurality of pairs of substrates in the individual regions for forming the substrates which are to be divided by cutting the large substrate along cutting projection lines, the thin films for forming the alignment layers are formed on a plurality of substrate-forming regions including the cutting projection lines.

[0015]

The method for fabricating the liquid crystal panel in accordance with the present invention, preferably, after the electrodes are formed on the surfaces of a pair of large substrates for forming a plurality of pairs of substrates in the regions for forming the individual substrates which are to be divided by cutting the large substrates along cutting projection lines, the thin films for forming the alignment layers are formed on the plurality of substrate-forming regions including the cutting projection lines in each of the pair of large substrates, the sealant is then disposed on at least one of the pair of large substrates to bond the large substrates to each other, and the bonded large substrates are cut along the cutting projection lines.

[0016]

In the method for fabricating the liquid crystal panel in accordance with the present invention, preferably, in the large substrate, the substrate-forming regions are placed with a cutting projection line therebetween so that the

sides provided with input-output terminals and terminals for conducting between substrates are directed in the opposite directions, and when the thin films for forming the alignment layers are formed, the thin films are formed in strip along the cutting projection line. If the thin films for forming the alignment layers are formed in strip, in flexographic printing, the end of a roller is directed to the side provided with input-output terminals and terminals for conducting between substrates. In such a width direction of the roller, unlike in the travelling direction of the roller, the printing regions can be controlled with high accuracy to a certain extent. In the width direction, even when the alignment layer cannot be formed up to the edge of the substrate, the alignment layer can be formed so as to be substantially adjacent to the region for forming the sealant, or to overlap the region for forming the sealant.

[0017]

[Description of the Embodiments]

The embodiments of the present invention will be described below with reference to the attached drawings.

[0018]

[FIRST EMBODIMENT]

(General Structure)

Fig. 1 is a perspective view of a liquid crystal

display device and Fig. 2 is an assembly view thereof. In Figs. 1 and 2, only portions of wiring patterns, terminals, etc. are shown, and the details thereof are shown in Figs. 3 and 4.

[0019]

In Figs. 1 and 2, a liquid crystal panel 10 of a liquid crystal display device mounted on an electronic apparatus, such as a mobile phone, includes a first substrate 1 composed of transparent glass or the like and a second substrate 2 also composed of transparent glass or the like. A sealant 3 containing a gap filler and conductive particles is disposed on one of the substrates by printing or the like, and the first substrate 1 and the second substrate 2 are bonded to each other with the sealant 3 therebetween. In this state, a predetermined gap is ensured between the first substrate 1 and the second substrate 2 by the gap filler contained in the sealant 3, and a liquid crystal 40 is enclosed in the gap in a liquid crystal filling region 41 which is delimited by the sealant 3. A polarizer 4A is attached to the outer surface of the first substrate 1 by an adhesive or the like, and a polarizer 4B is attached to the outer surface of the second substrate 2 by an adhesive or the like. When the liquid crystal panel 10 is fabricated as a reflection type, a reflector (not shown in the drawing) is attached to the exterior of the polarizer 4B provided on the

second substrate 2 or is directly attached to the outer surface of the second substrate 2 instead of the polarizer 4B.

[0020]

In this embodiment, since the second substrate 2 is larger than the first substrate 1, when the first substrate 1 is overlaid on the second substrate 2, a portion of the second substrate 2 protrudes from the lower edge of the first substrate 1. In a protruding section 110, an IC mounting region 9 is formed so as to adjoin the liquid crystal filling region 41, and a driver IC 33 is mounted thereon by a COG (Chip On Glass) method.

[0021]

In the second substrate 2, a plurality of input-output terminals 7D are formed along the edge of the substrate so as to adjoin the IC mounting region 9 on the lower edge side of the IC mounting region 9. A flexible substrate 29 is connected to the input-output terminals 7D, as shown by two-dot chain lines in Fig. 1.

[0022]

Figs. 3 and 4 are plan views which show the configuration patterns of transparent electrodes formed on the first substrate 1 and the second substrate 2, respectively.

[0023]

In Fig. 3, an electrode pattern 6, which includes electrodes 6A for displaying characters or for displaying dots and terminals 6C for conducting between substrates lying along a side 101 in order to obtain conduction to the second substrate 2 in the exterior to the liquid crystal filling region 41, is formed on the inner surface of the first substrate 1 inside the liquid crystal filling region 41 delimited by the sealant 3. The electrode pattern 6 is composed of an ITO film or the like.

[0024]

In Fig. 4, an electrode pattern 7, which includes electrodes 7A for displaying characters or for displaying dots, a wiring section 7B for wiring the electrodes 7A toward the IC mounting region 9 in the exterior of the liquid crystal filling region 41, terminals 7C for conducting between substrates lying along the side 201 side of the liquid crystal filing region 41 in order to obtain conduction to the first substrate 1 in the exterior of the liquid crystal filling region 41, and the input-output terminals 7D lying along the side 201, is formed on the surface of the second substrate 2. The electrode pattern 7 is also composed of an ITO film or the like.

[0025]

When the first substrate 1 and the second substrate 2 having the structures described above are bonded to each

other as shown in Fig. 1 and Figs. 5(A) and 5(B), since the terminals 6C of the first substrate 1 and the terminals 7C of the second substrate 2 are opposed to each other, the conductive particles contained in the sealant 3 interposed between the terminals 6C and 7C electrically connect the terminals 6C and 7C, and thus conduction between the first substrate 1 and the second substrate 2 is enabled. That is, the conductive particles contained in the sealant 3 are composed of elastically deformable plastic beads plated with nickel or gold, and have a particle size of about 5 to 9 μm. In contrast, the gap filler contained in the sealant 3 has a particle size of about 4 to 8 μm. Therefore, when the sealant 3 is melted and hardened while the first substrate 1 is superposed on the second substrate 2 and pressure is applied so as to narrow the gap, the conductive particles, in a squeezed state between the first substrate 1 and the second substrate 2, electrically connect the terminals 6C of the first substrate 1 to the terminals 7C of the second substrate 2.

[0026]

Since electrodes 6A of the first substrate 1 and the electrodes 7A of the second substrate 2 are opposed to each other in a state in which the first substrate 1 and the second substrate 2 are bonded to each other, by applying an electric field to the liquid crystal 40 through the

electrodes 6A and 7A, the alignment state of the liquid crystal 40 can be controlled, and desired images can be displayed on the liquid crystal panel 10.

[0027]

(Structures of transparent insulation films and alignment layers)

Figs. 5(A) and 5(B) are, respectively, a sectional view of the liquid crystal panel shown in Fig. 1 and an enlarged sectional view of the end thereof. Fig. 6 is a plan view of the liquid crystal panel shown in Fig. 1, schematically showing the relationship between the region for forming the alignment layers and the region for forming the sealant.

[0028]

In the liquid crystal panel 10 having such a structure, as shown in Figs. 5(A) and 5(B), in the first substrate 1 and the second substrate 2, transparent insulation films 12 and 22 are formed so as to cover the electrodes 6A and 7A, and on the surfaces of the transparent insulation films 12 and 22, alignment layers 13 and 23 composed of polyimide films are formed. The alignment layers 13 and 23 are the polyimide films which are subjected to rubbing treatment, and the liquid crystal 40 is used in the STN (Super Twisted Nematic) mode.

[0029]

As shown in Figs. 5(A) and 5(B) and Fig. 6 (the region

for forming alignment layers 13 and 23 and transparent insulation films 12 and 22 is shown by slanted broken lines, and the region for forming the sealant 3 are shown by slanted solid lines), in both the first substrate 1 and the second substrate 2, the transparent insulation films 12 and 22 and the alignment layers 13 and 23 are formed up to the region overlapping the region for forming the sealant 3 in the sections corresponding to four sides 101 to 104 and 201 to 204 of the first and second substrates 1 and 2, respectively.

[0030]

As the sealant 3, in this embodiment, a one-part thermosetting epoxy sealant, which has good adhesion even to polyimide films constituting the alignment layers 13 and 23, is used. For example, a Structbond ES series (trade name) sealant manufactured by Mitsui Toatsu Kagaku K.K. is used. In the one-part thermosetting epoxy sealant, a latent curing agent, such as dicyandiamide, a dihydrazide, or an imidazole, is dispersed in an epoxy resin, and an inorganic filler, a solvent, a viscosity modifier, etc. are further mixed thereto. To this system, a high-impact epoxy, in which an acrylic or silicone rubber is graft-polymerized to an epoxy resin (i.e., technique for producing high impact epoxy), is mixed. Therefore, among one-part thermosetting epoxy sealants, since the Structbond ES series sealant

manufactured by Mitsui Toatsu Kagaku K.K. has excellent adhesion even to polyimide films, even if the sealant 3 is formed so as to overlap the surfaces of the alignment layers 13 and 23, excellent water-tightness and airtightness are exhibited at the interfaces.

[0031]

When the regions for forming the alignment layers 13 and 23 are defined, since terminals 6C for conducting to the second substrate 2 are formed in the section corresponding to the side 101 of the first substrate 1, and terminals 7C for conducting to the first substrate 1 and the input-output terminals 7D are formed in the section corresponding to the side 201 of the second substrate 2, if the terminals 6C, 7C, and 7D are covered with the alignment layers 13 and 23, electrical continuity cannot be obtained. Thus, in this embodiment, among the four sides 101 to 104 and 201 to 204 of the first and second substrates 1 and 2, in the sections corresponding to the sides 101 and 201 in which the terminals 6C and 7C for conduction and the input-output terminals 7D are formed, the alignment layers 13 and 23 are formed so as to partially overlap the regions for forming the sealant 3, and in the sections corresponding to the other three sides 102 to 104 and 202 to 204, the alignment layers 13 and 23 are formed up to the edges of the first and second substrates 1 and 2.

[0032]

The transparent insulation films 12 and 22, which are formed so as to cover the electrodes 6C and 7C, are formed so as to substantially overlap the alignment layers 13 and 23. That is, with respect to the transparent insulation films 12 and 22, if the terminals 6C and 7C for conduction and the input-output terminals 7D of the first and second substrates 1 and 2 are covered, electrical continuity cannot be obtained. Thus, among the four sides 101 to 104 and 201 to 204 of the first and second substrates 1 and 2, in the sections corresponding to the sides 101 and 201 in which the terminals 6C and 7C for conduction and the input-output terminals 7D are formed, the transparent insulation films 12 and 22 are formed so as to partially overlap the region for forming the sealant 3, and in the sections corresponding to the other three sides 102 to 104 and 202 to 204, the transparent insulation films 12 and 22 are formed up to the edges of the first and second substrates 1 and 2.

[0033]

Therefore, in the liquid crystal panel 10 in this embodiment, as shown in Fig. 5(B), since there is no space between the sealant 3 and the alignment layers 13 and 23, low twist domains do not occur in the liquid crystal 40 in the vicinity of the inner periphery of the sealant 3. Consequently, since the vicinity of the inner periphery of

the sealant 3 can also be used as the effective region for displaying images, the region for displaying images can be enlarged.

[0034]

(Method for Fabricating Liquid Crystal Panel)

A method of fabricating the liquid crystal panel 10 having such a structure will be described with reference to Figs. 5(A), 5(B), and 7. Fig. 7 is a schematic diagram which shows first and second large substrates 1A and 2A for forming a plurality of first and second substrates 1 and 2, respectively, regions for forming the transparent insulation films 12 and 22 and the alignment layers 13 and 23 formed on the first and second large substrates 1A and 2A, and regions for forming the sealant 3 in the fabrication process of the liquid crystal panel shown in Fig. 1. In Fig. 7, the first and second large substrates 1A and 2A for forming a plurality of first and second substrates 1 and 2, respectively, regions for forming the transparent insulation films 12 and 22 and the alignment layers 13 and 23 (regions marked by slanted broken lines) in relation to the first and second large substrates 1A and 2A, and regions for forming the sealant 3 (regions marked by slanted solid lines) are shown and other components are omitted. Thus, the individual components to be formed on the first and second large substrates 1A and 2A will be described with reference

to Figs. 5(A) and 5(B).

[0035]

First, as shown in Figs. 5(A) and 5(B) and Fig. 7, after underlayer protective films 11 and 21 are formed over the surfaces of the first and second large substrates 1A and 2A for forming a plurality of first and second substrates 1 and 2, respectively, electrode patterns 6 and 7 including the electrodes 6A and 7A and the terminals 6C and 7C are formed by photolithography in the individual substrate-forming regions, which are to be divided into the first and second substrates 1 and 2 by cutting the large substrates 1A and 2A along the cutting projection lines L1 and L2.

[0036]

Next, with respect to the first and second large substrates 1A and 2A, transparent insulation films 12 and 22 composed of silicon oxide films are formed so as to cover the electrodes 6A and 7A. The transparent insulation films 12 and 22 are formed in strip covering a plurality of substrate-forming regions including the cutting projection lines L1 and L2. That is, in the first and second large substrates 1A and 2A, the substrate-forming regions are disposed with the cutting projection line L2 therebetween so that the sides 101 and 201, in which the input-output terminals 12 and the terminals 6C and 7C for conducting between substrates are formed, are directed in the opposite

directions, and the transparent insulation films 12 and 22 are formed in strip along the cutting projection line L2. As a result, when the first and second large substrates 1A and 2A are divided into single first and second substrates 1 and 2 by cutting along the cutting projection lines L1 and L2, in the sections corresponding to the four sides 101 to 104 and 201 to 204 of the first and second substrates 1 and 2, the transparent insulation films 12 and 22 are formed so as to be superposed on the regions for forming the sealant 3. In the sections corresponding to three sides 102 to 104 and 202 to 204, excluding the sides 101 and 201 in which the terminals 6A and 7A for conducting between substrates and the input-output terminals 7D are formed, among the four sides 101 to 104 and 201 to 204 of the first and second substrates 1 and 2, the transparent insulation films 12 and 22 are formed up to the edges of the first and second substrates 1 and 2 across the regions for forming the sealant 3, and in the sections corresponding to the sides 101 and 201 in which the terminals 6A and 7A for conducting between substrates and the input-output terminals 7D are formed, the transparent insulation films 12 and 22 are formed so as to partially overlap the regions for forming the sealant 3.

[0037]

Next, polyimide films (alignment layers 13 and 23) are

formed by flexographic printing so as to cover the transparent insulation films 12 and 22 in the first and second large substrates 1A and 2A. The polyimide films (alignment layers 13 and 23) are also formed in strip over the plurality of substrate-forming regions including the cutting projection lines L1 and L2. That is, in the first and second large substrates 1A and 2A, since the substrate-forming regions are disposed with the cutting projection line L2 therebetween so that the sides 101 and 201, in which the input-output terminals 7D and terminals 6C and 7C for conducting between substrates are formed, are directed in the opposite directions, the polyimide films (alignment layers 13 and 23) are formed in strip along the cutting projection line L2 by moving a roller in a flexographic printer along the cutting projection line L2 with the end of the roller being directed toward the sides 101 and 201. As a result, when the first and second large substrates 1A and 2A are divided into single first and second substrates 1 and 2 by cutting along the cutting projection lines L1 and L2, in the sections corresponding to the four sides 101 to 104 and 201 to 204 of the first and second substrates 1 and 2, the polyimide films (alignment layers 13 and 23) are formed so as to be superposed on the regions for forming the sealant 3. In the sections corresponding to three sides 102 to 104 and 202 to 204, excluding the sides 101 and 201 in

which the terminals 6A and 7A for conducting between substrates and the input-output terminals 7D are formed, among the four sides 101 to 104 and 201 to 204 of the first and second substrates 1 and 2, the polyimide films (alignment layers 13 and 23) are formed up to the edges of the first and second substrates 1 and 2 across the regions for forming the sealant 3, and in the sections corresponding to the sides 101 and 201 in which the terminals 6A and 7A for conducting between substrates and the input-output terminals 7D are formed, the polyimide films (alignment layers 13 and 23) are formed so as to partially overlap the regions for forming the sealant 3.

[0038]

Next, rubbing treatment is performed on the first and second large substrates to form the alignment layers 13 and 23 from the polyimide films.

[0039]

Next, with respect to the second large substrate 2A, after the sealant 3 is printed on the surfaces of the alignment layers 13 and 23, pre-baking is performed, and then the first large substrate 1A and the second large substrate 2A are bonded to each other with the sealant 3 therebetween. At this stage, as shown in Fig. 5(A), after spacers 32 are scattered on the first large substrate 1, the first large substrate 1A and the second large substrate 2A

are bonded to each other.

[0040]

Referring again to Figs. 5(A) and 5(B) and Fig. 7, after the first large substrate 1A and the second large substrate 2A are bonded to each other, the bonded first large substrate 1A and second large substrate 2A are divided into single liquid crystal panels 10 by cutting along the cutting projection lines L1 and L2, or the bonded first large substrate 1A and second large substrate 2A are divided into strip panels by cutting along the cutting projection lines L1. In either state of cutting, openings 30 of the sealant 3 are opened in the cut surfaces (corresponding to the sides 104 and 204).

[0041]

Consequently, when the regions delimited by the sealant 3 in the gap between the first and second substrates 1 and 2 are evacuated and the openings 30 are immersed in the liquid crystal so as to be exposed to atmosphere, the liquid crystal 40 is injected into the regions delimited by the sealant 3. Thus, by closing the openings 30 of the sealant 3 after the liquid crystal 40 is injected, the liquid crystal 40 is enclosed in the gap 31 between the first and second substrates 1 and 2.

[0042]

At this stage, if the single liquid crystal panels 10

are separated, as shown in Fig. 1 and Figs. 5(A) and 5(B), the polarizers 4A and 4B, etc. are attached thereto. On the other hand, if the strip panels are separated, after dividing the strip panels into single liquid crystal panels 10, the polarizers 4A and 4B, etc. are attached thereto.

[0043]

Next, as shown in Fig. 1, the flexible substrate 29 is contact-bonded to the input-output terminals 7D of the second substrate 2 using an anisotropic conductive film or the like, and is delivered to the inspection step.

[0044]

As described above, in accordance with the fabrication method in this embodiment, since the polyimide films are applied all over in the roller travelling direction of a flexographic printer (the direction shown by an arrow X in Fig. 7), even if the printing regions for the alignment layers 13 and 23 cannot be controlled in this direction, spaces do not occur between the sealant 3 and the alignment layer 13 or 23. In the roller width direction in flexographic printing (the direction shown by an arrow Y in Fig. 7), although it is necessary to control the printing regions so that the alignment layers 13 and 23 do not cover the terminals 6A and 7A for conducting between substrates and the input-output terminals 7D, in such a direction, it is relatively easy to control the printing regions in the

flexographic printer, and spaces do not occur between the sealant 3 and the alignment layer 13 or 23 in this direction.

[0045]

[SECOND EMBODIMENT]

Fig. 8 is a schematic diagram which shows first and second large substrates for forming a plurality of first and second substrates, respectively, regions for forming transparent insulation films and alignment layers (regions marked by broken lines slanting to the left) on the first and second large substrates, and regions for forming the sealant (regions marked by solid lines slanting to the right) in the fabrication process of a liquid crystal panel in accordance with a second embodiment of the present invention. Since the basic structure of the liquid crystal panel in this embodiment is in common with that of the liquid crystal panel in accordance with the first embodiment, the same numerals are used for the corresponding sections in Fig. 8, and the detailed description thereof will be omitted.

[0046]

As shown in Fig. 8, in this embodiment, transparent insulation films 12 and 22 composed of silicon oxide films are formed on first and second large substrates 1A and 2A so as to cover electrodes 6A and 7A (refer to Figs. 3, 4, 5(A), and 5(B)). Although the transparent insulation films 12 and 22 cover cutting projection lines L1, they do not cover the

cutting projection line L2, and the transparent insulation films 12 and 22 are formed in strip by each row, covering a plurality of substrate-forming regions. As a result, when the first and second large substrates 1A and 2A are divided into single first and second substrates 1 and 2 by cutting along the cutting projection lines L1 and L2, in the sections corresponding to the four sides 101 to 104 and 201 to 204 of the first and second substrates 1 and 2, the transparent insulation films 12 and 22 are formed so as to be superposed on the regions for forming the sealant 3. In the sections corresponding to two sides 102 and 104, and 202 and 204, excluding the sides 101 and 201 in which the terminals 6A and 7A for conducting between substrates and the input-output terminals 7D are formed and the sides 103 and 203 lying on the side of the cutting projection line L2, among the four sides 101 to 104 and 201 to 204 of the first and second substrates 1 and 2, the transparent insulation films 12 and 22 are formed up to the edges of the first and second substrates 1 and 2 across the regions for forming the sealant 3.

[0047]

Next, polyimide films (alignment layers 13 and 23) are formed by flexographic printing so as to cover the transparent insulation films 12 and 22 in the first and second large substrates 1A and 2A. The polyimide films also

cover the cutting projection lines L1 and do not cover the cutting projection line L2. The polyimide films are formed in strip by each row over a plurality of substrate-forming regions. As a result, when the first and second large substrates 1A and 2A are divided into single first and second substrates 1 and 2 by cutting along the cutting projection lines L1 and L2, in the sections corresponding to the four sides 101 to 104 and 201 to 204 of the first and second substrates 1 and 2, the polyimide films (alignment layers 13 and 23) are disposed so as to be superposed on the regions for forming the sealant 3. In the sections corresponding to two sides 102 and 104, and 202 and 204, excluding the sides 101 and 201 in which the terminals 6A and 7A for conducting between substrates and the input-output terminals 7D are formed and the sides 103 and 203 lying on the side of the cutting projection line L2, among the four sides 101 to 104 and 201 to 204 of the first and second substrates 1 and 2, the polyimide films (alignment layers 13 and 23) are formed up to the edges of the first and second substrates 1 and 2 across the regions for forming the sealant 3.

[0048]

[THIRD EMBODIMENT]

Fig. 9 is a schematic diagram which shows first and second large substrates for forming a plurality of first and

second substrates, respectively, regions for forming transparent insulation films and alignment layers (regions marked by broken lines slanting to the left) on the first and second large substrates, and regions for forming the sealant (regions marked by solid lines slanting to the right) in the fabrication process of a liquid crystal panel in accordance with a third embodiment of the present invention. Since the basic structure of the liquid crystal panel in this embodiment is in common with that of the liquid crystal panel in accordance with the first embodiment, the same numerals are used for the corresponding sections in Fig. 9, and the detailed description thereof will be omitted.

[0049]

As shown in Fig. 9, in this embodiment, transparent insulation films 12 and 22 composed of silicon oxide films are formed on first and second large substrates 1A and 2A so as to cover electrodes 6A and 7A (refer to Figs. 3, 4, 5(A), and 5(B)). Although the transparent insulation films 12 and 22 cover a cutting projection line L2, they do not cover the cutting projection lines L1, and the transparent insulation films 12 and 22 are formed in strip, covering a plurality of substrate-forming regions. As a result, when the first and second large substrates 1A and 2A are divided into single first and second substrates 1 and 2 by cutting along the cutting projection lines L1 and L2, in the sections

corresponding to the four sides 101 to 104 and 201 to 204 of the first and second substrates 1 and 2, the transparent insulation films 12 and 22 are formed so as to be superposed on the regions for forming the sealant 3. In the sections corresponding to the sides 103 and 203 lying on the side of the cutting projection line L2, among the four sides 101 to 104 and 201 to 204 of the first and second substrates 1 and 2, the transparent insulation films 12 and 22 are formed up to the edges of the first and second substrates 1 and 2 across the regions for forming the sealant 3.

[0050]

Polyimide films (alignment layers 13 and 23) are formed by flexographic printing so as to cover the transparent insulation films 12 and 22 in the first and second large substrates 1A and 2A. The polyimide films (alignment layers 13 and 23) also cover the cutting projection line L2 and do not cover the cutting projection lines L1. The polyimide films are formed in strip over a plurality of substrate-forming regions. As a result, when the first and second large substrates 1A and 2A are divided into single first and second substrates 1 and 2 by cutting along the cutting projection lines L1 and L2, in the sections corresponding to the four sides 101 to 104 and 201 to 204 of the first and second substrates 1 and 2, the polyimide films (alignment layers 13 and 23) are disposed so as to be superposed on the

regions for forming the sealant 3. In the sections corresponding to the sides 103 and 203 lying on the side of the cutting projection line L2, among the four sides 101 to 104 and 201 to 204 of the first and second substrates 1 and 2, the polyimide films (alignment layers 13 and 23) are formed up to the edges of the first and second substrates 1 and 2 across the regions for forming the sealant 3.

[0051]

[FOURTH EMBODIMENT]

Fig. 10 is a schematic diagram which shows first and second large substrates for forming a plurality of first and second substrates, respectively, regions for forming transparent insulation films and alignment layers (regions marked by broken lines slanting to the left) on the first and second large substrates, and regions for forming the sealant (regions marked by solid lines slanting to the right) in the fabrication process of a liquid crystal panel in accordance with a fourth embodiment of the present invention. Since the basic structure of the liquid crystal panel in this embodiment is in common with that of the liquid crystal panel in accordance with the first embodiment, the same numerals are used for the corresponding sections in Fig. 10, and the detailed description thereof will be omitted.

[0052]

As shown in Fig. 10, in this embodiment, transparent insulation films 12 and 22 composed of silicon oxide films are formed on first and second large substrates 1A and 2A so as to cover electrodes 6A and 7A (refer to Figs. 3, 4, 5(A), and 5(B)). The transparent insulation films 12 and 22 do not cover cutting projection lines L1 and L2, and are formed independently by each substrate-forming region. However, when the first and second large substrates 1A and 2A are divided into single first and second substrates 1 and 2 by cutting along the cutting projection lines L1 and L2, in the sections corresponding to the four sides 101 to 104 and 201 to 204 of the first and second substrates 1 and 2, the transparent insulation films 12 and 22 are formed so as to be superposed on the regions for forming the sealant 3.

[0053]

Polyimide films (alignment layers 13 and 23) are formed by flexographic printing so as to cover the transparent insulation films 12 and 22 in the first and second large substrates 1A and 2A. The polyimide films (alignment layers 13 and 23) do not cover the cutting projection lines L1 and L2, and are formed independently for each substrate-forming region. However, the polyimide films (alignment layers 13 and 23) are disposed so as to be superposed on the regions for forming the sealant 3 when the first and second large substrates 1A and 2A are divided into single first and

second substrates 1 and 2 by cutting along the cutting projection lines L1 and L2, in the sections corresponding to the four sides 101 to 104 and 201 to 204 of the first and second substrates 1 and 2.

[0054]

[OTHER EMBODIMENTS]

Although, in any one of the embodiments described above, the transparent insulation films 12 and 22 and the polyimide films (alignment layers 13 and 23) are formed so as to be superposed on the regions for forming the sealant 3 at the four sides of the substrate, the transparent insulation films 12 and 22 and the polyimide films (alignment layers 13 and 23) may be superposed on the regions for forming the sealant 3 at least at the three sides of the substrate. For example, the regions for forming the transparent insulation films 12 and 22 and the polyimide films (alignment layers 13 and 23) may be formed in the interior of the regions for forming the sealant 3 at the sides 101 and 201 in which terminals 6A and 7A for conducting between substrates and input-output terminals 7D are formed, among the four sides 101 to 104 and 201 to 204 of the first and second substrates 1 and 2.

[0055]

Although examples of passive matrix-type liquid crystal panels have been described, the present invention is also

applicable to active matrix-type liquid crystal panels.

[0056]

Furthermore, although, in accordance with the embodiments, alignment layers, etc. are formed in the stage of large substrates, and after the large substrates are bonded to each other, they are divided into single liquid crystal panels, the present invention is also applicable to the case in which electrodes, alignment layers, etc. are formed on single substrates.

[0057]

[Advantages]

As described above, in the liquid crystal panels and methods for fabricating the same in accordance with the present invention, since alignment layers are formed up to the regions overlapping the regions for forming a sealant, there is no space between the sealant and the alignment layers. Consequently, low twist domains do not occur in the vicinity of the inner periphery of the sealant. Therefore, the vicinity of the inner periphery of the sealant can be effectively used as the region for displaying images, and thus the region for displaying images can be enlarged.

[Brief Description of the Drawings]

[Fig. 1]

Fig. 1 is a perspective view of a liquid crystal display device.

[Fig. 2]

Fig. 2 is an assembly view of a liquid crystal panel used in the liquid crystal display device shown in Fig. 1.

[Fig. 3]

Fig. 3 is a plan view which shows the configuration pattern of transparent electrodes formed on a first substrate of the liquid crystal panel shown in Fig. 1.

[Fig. 4]

Fig. 4 is a plan view which shows the configuration pattern of transparent electrodes formed on a second substrate of the liquid crystal panel shown in Fig. 1.

[Fig. 5]

Figs. 5(A) and 5(B) are a sectional view of the liquid crystal panel shown in Fig. 1 and an enlarged sectional view of the end thereof, respectively.

[Fig. 6]

Fig. 6 is a plan view of the liquid crystal panel shown in Fig. 1, schematically showing the relationship between the region for forming alignment layers and the region for forming a sealant.

[Fig. 7]

Fig. 7 is a schematic diagram which shows first and second large substrates for forming a plurality of first and second substrates, respectively, a region for forming transparent insulation films and alignment layers (region

marked by broken lines slanting to the left) formed on the first and second large substrates, and regions for forming the sealant (regions marked by solid lines slanting to the right) in the fabrication process of the liquid crystal panel shown in Fig. 1.

[Fig. 8]

Fig. 8 is a schematic diagram which shows first and second large substrates for forming a plurality of first and second substrates, respectively, regions for forming transparent insulation films and alignment layers (regions marked by broken lines slanting to the left) formed on the first and second large substrates, and regions for forming the sealant (regions marked by solid lines slanting to the right) in the fabrication process of a liquid crystal panel in accordance with a second embodiment of the present invention.

[Fig. 9]

Fig. 9 is a schematic diagram which shows first and second large substrates for forming a plurality of first and second substrates, respectively, regions for forming transparent insulation films and alignment layers (regions marked by broken lines slanting to the left) formed on the first and second large substrates, and regions for forming the sealant (regions marked by solid lines slanting to the right) in the fabrication process of a liquid crystal panel

in accordance with a third embodiment of the present invention.

[Fig. 10]

Fig. 10 is a schematic diagram which shows first and second large substrates for forming a plurality of first and second substrates, respectively, regions for forming transparent insulation films and alignment layers (regions marked by broken lines slanting to the left) formed on the first and second large substrates, and regions for forming the sealant (regions marked by solid lines slanting to the right) in the fabrication process of a liquid crystal panel in accordance with a fourth embodiment of the present invention.

[Fig. 11]

Figs. 11(A) and 11(B) are a sectional view of a conventional liquid crystal panel and an enlarged sectional view of the end thereof, respectively.

[Fig. 12]

Fig. 12 is a schematic diagram which shows first and second large substrates for forming a plurality of first and second substrates, respectively, regions for forming transparent insulation films and alignment layers (regions marked by lines slanting to the left) formed on the first and second large substrates, and regions for forming the sealant (regions marked by lines slanting to the right) in

the fabrication process of the conventional liquid crystal panel shown in Figs. 11(A) and 11(B).

[Reference Numerals]

1: first substrate

2: second substrate

3: sealant

4A and 4B: polarizer

6 and 7: electrode pattern (thin-film pattern)

6A and 7A: electrode for controlling the alignment state of liquid crystal

6C and 7C: terminal for conducting between substrates

7D: input-output terminal

9: IC mounting region

10: liquid crystal panel

12 and 22: transparent insulation film

13 and 23: alignment layer

33: driver IC

29: flexible substrate (substrate)

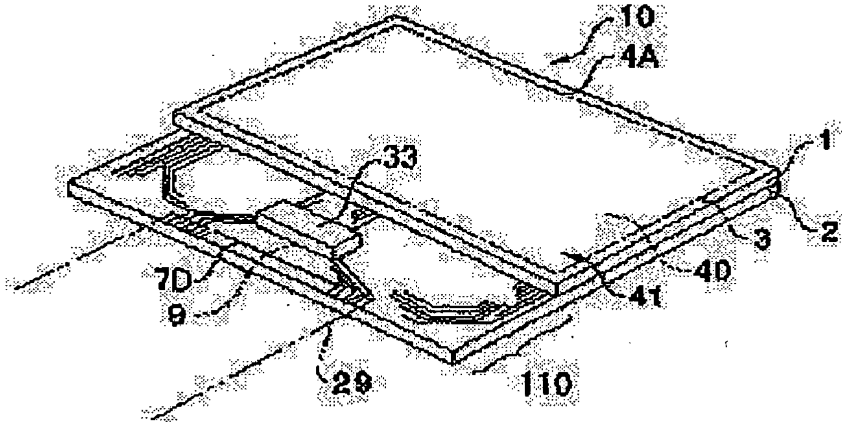
40: liquid crystal

41: liquid crystal filling region

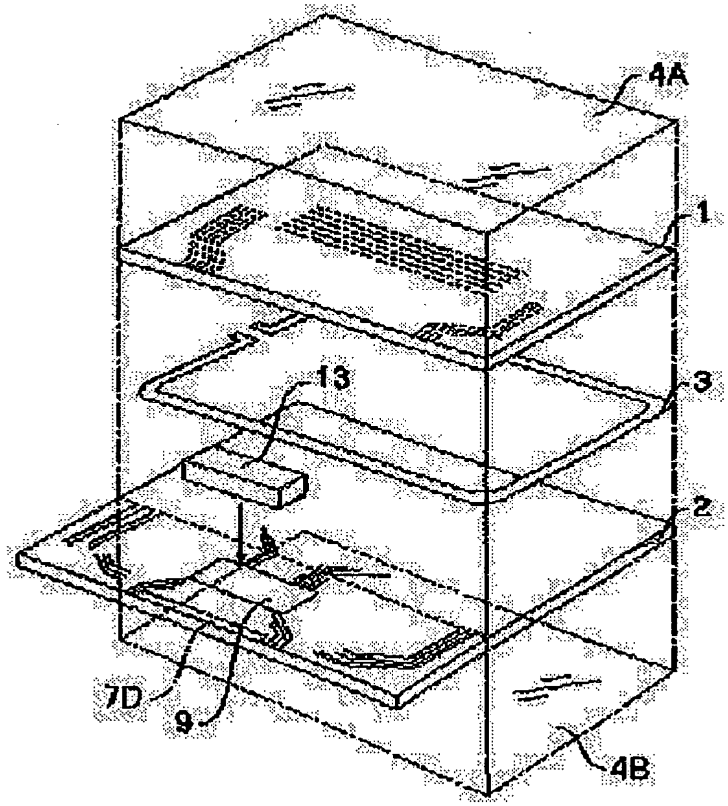
101 to 104: side of first substrate

201 to 204: side of first substrate

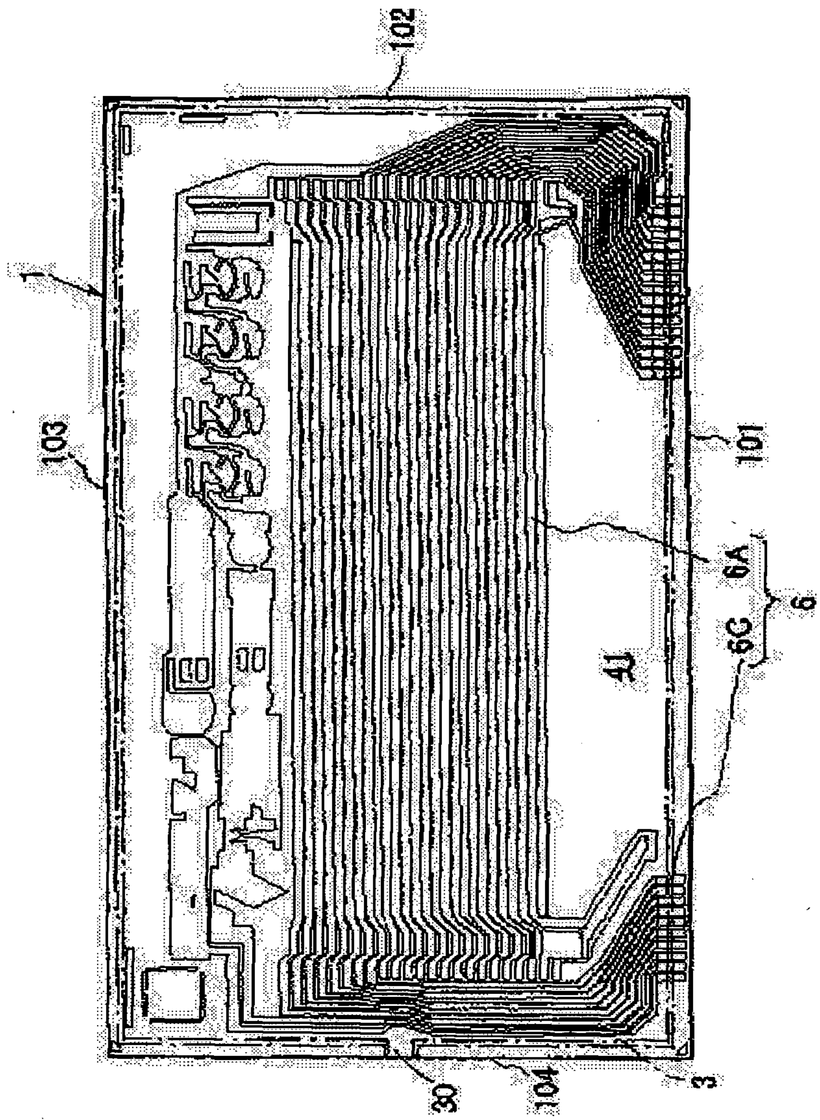
[FIG. 1]



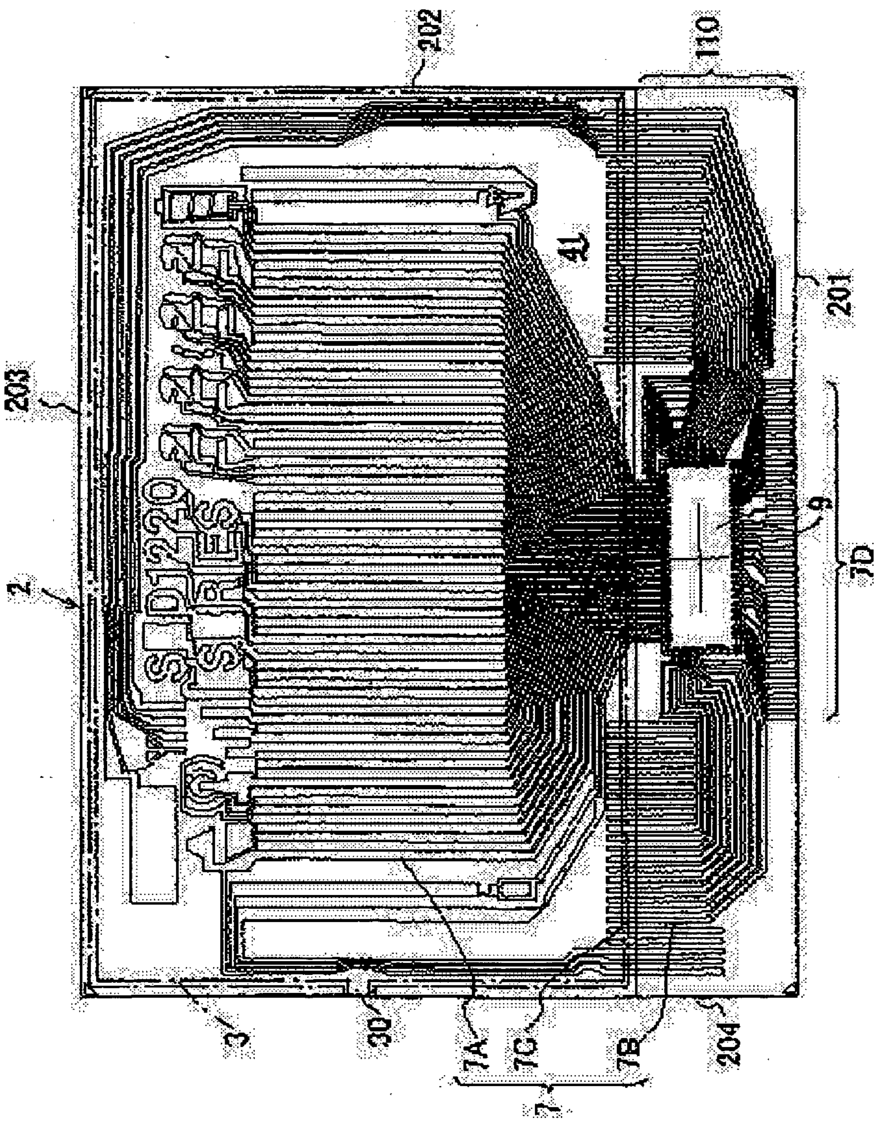
[FIG. 2]



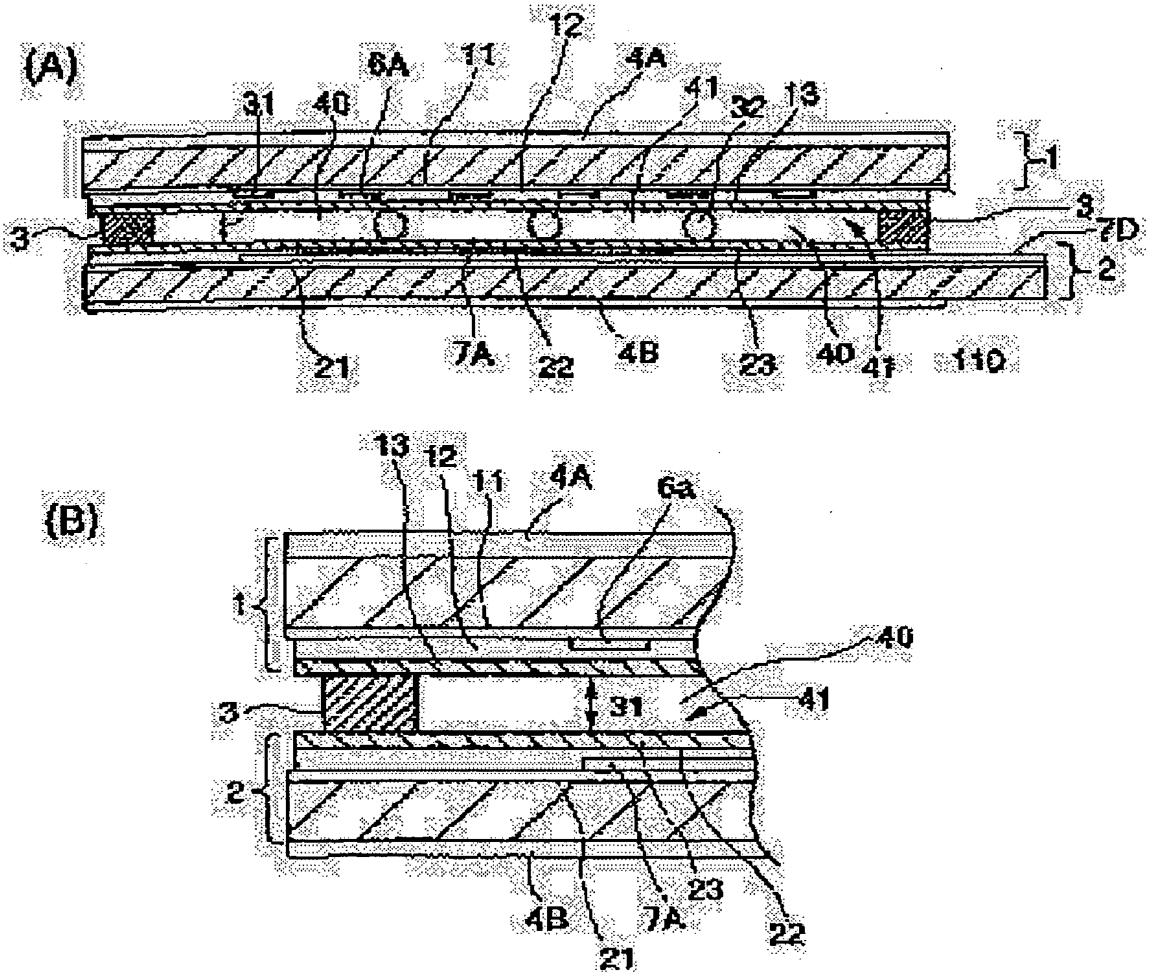
[FIG. 3]



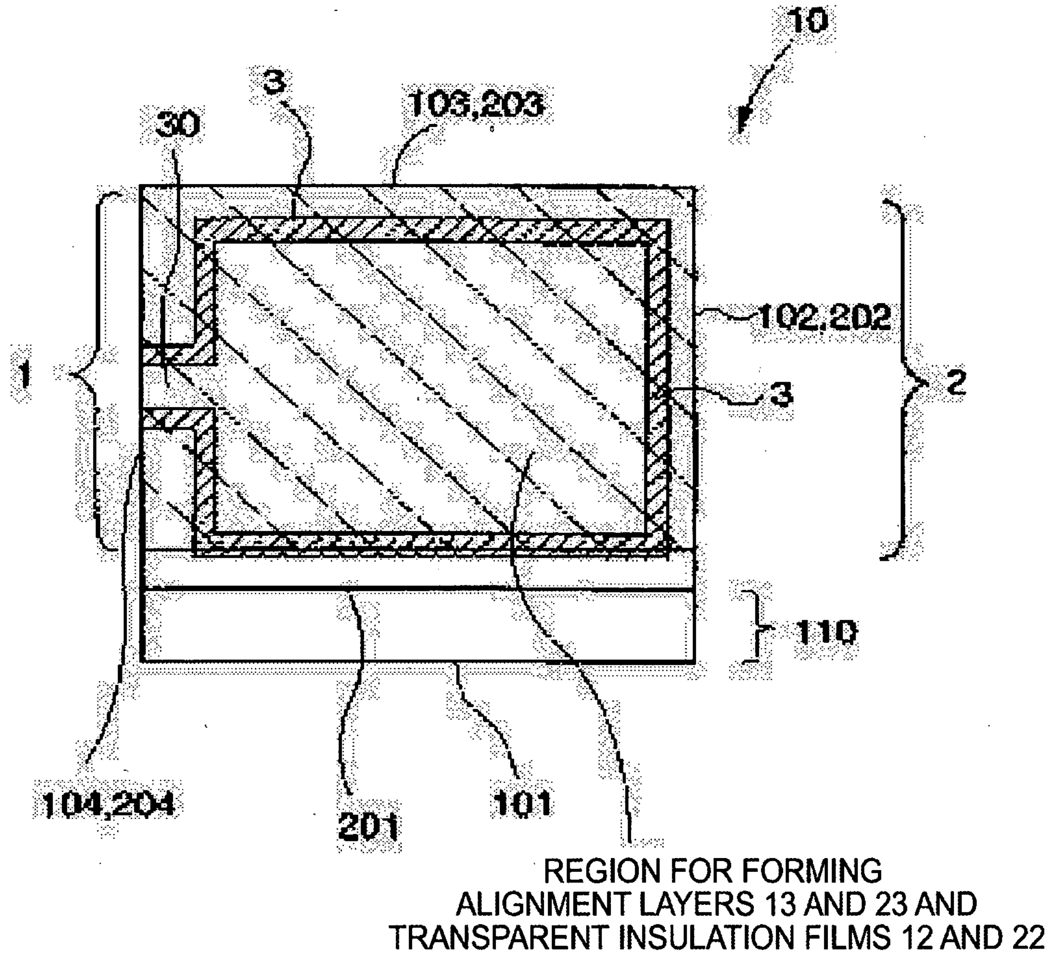
[FIG. 4]



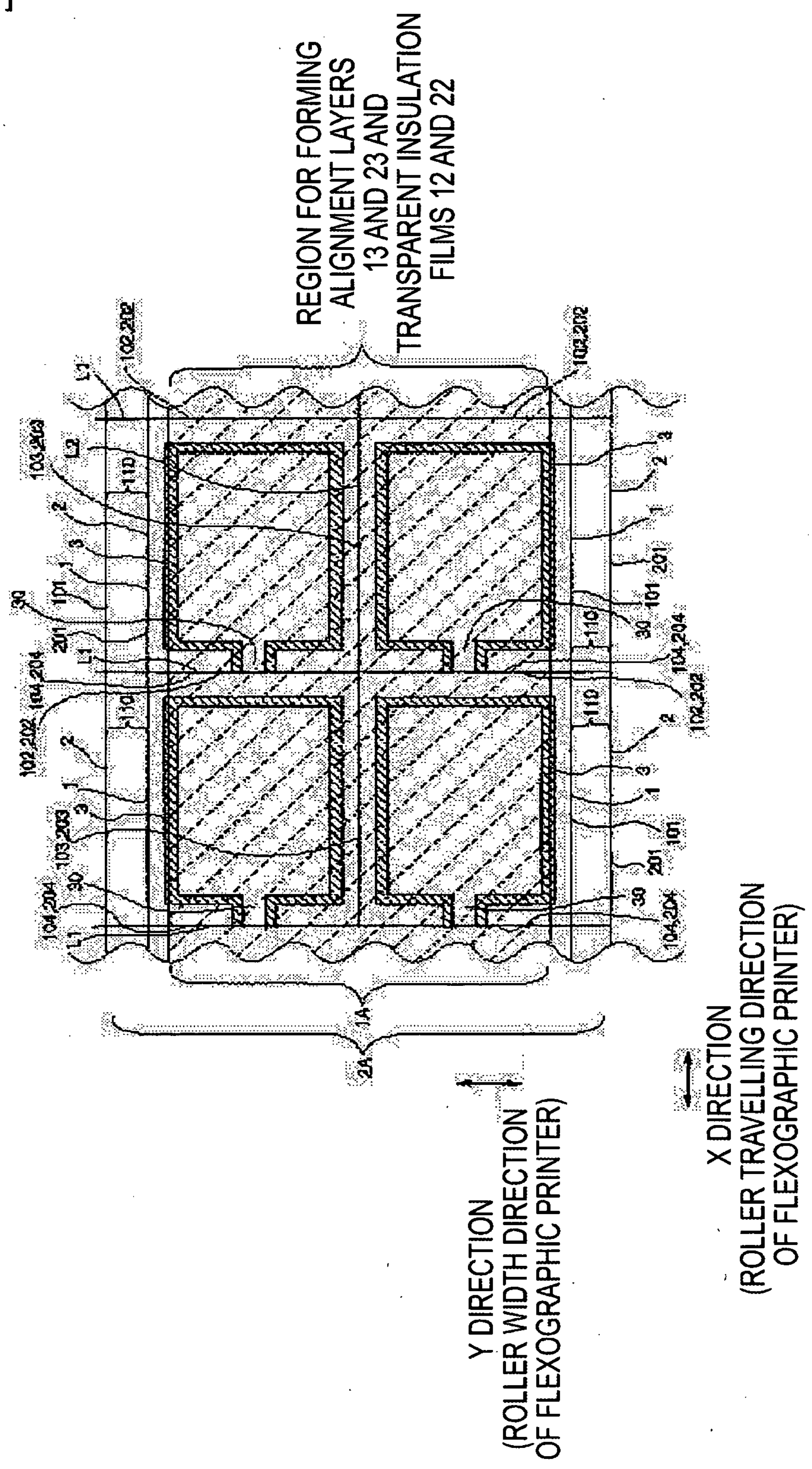
[FIG. 5]


(A)
12
6A
11
4A
31
40
41
32
13
1
3
3
7D
2
21
7A
22
4B
23
40
41
110
(B)
13
12
11
4A
6a
1
40
3
31
41
2
4B
21
7A
23
22

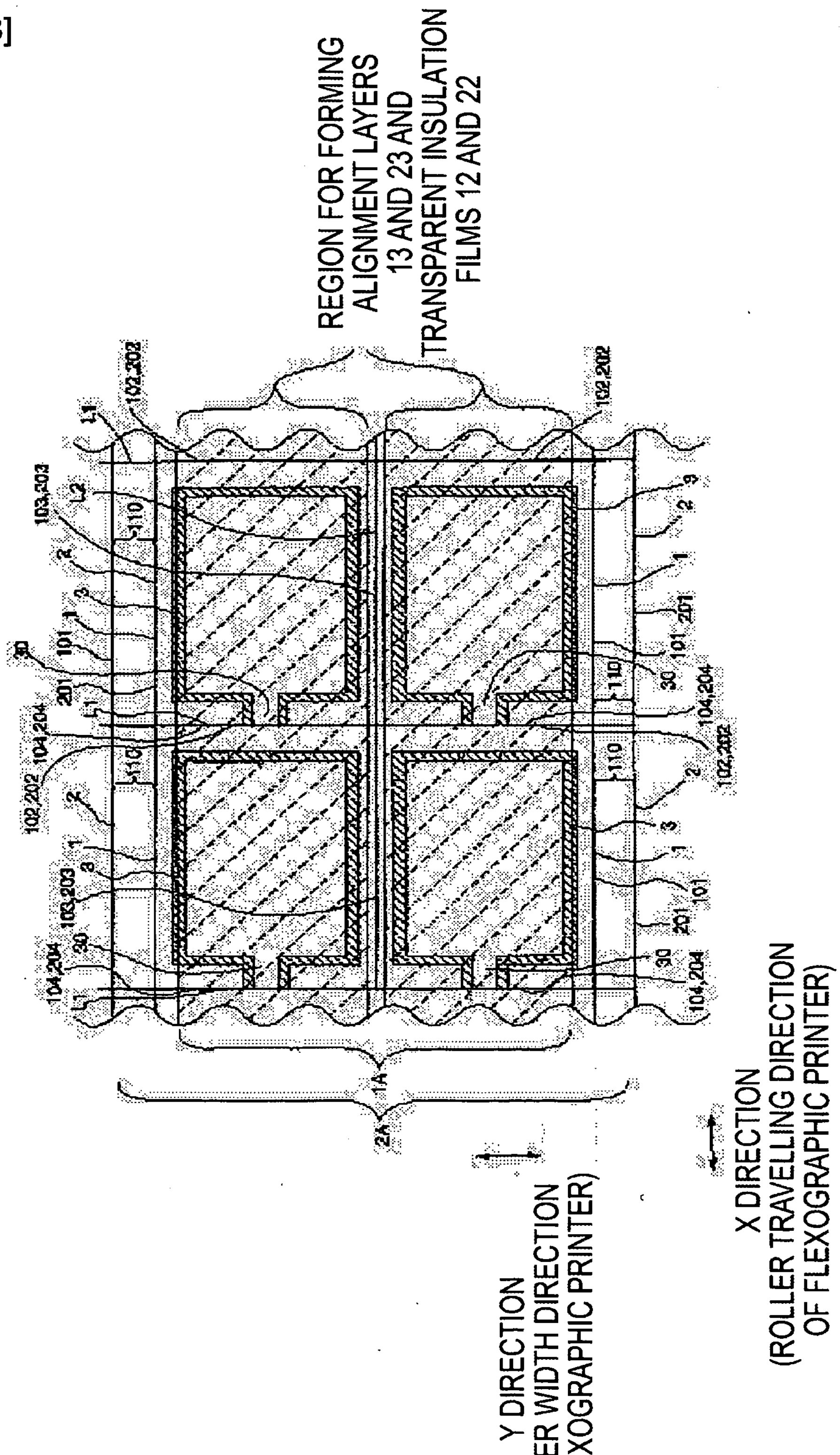
[FIG. 6]


10
3
103,203
30
102,202
3
1
2
110
104,204
201
101
REGION FOR FORMING
ALIGNMENT LAYERS 13 AND 23 AND
TRANSPARENT INSULATION FILMS 12 AND 22

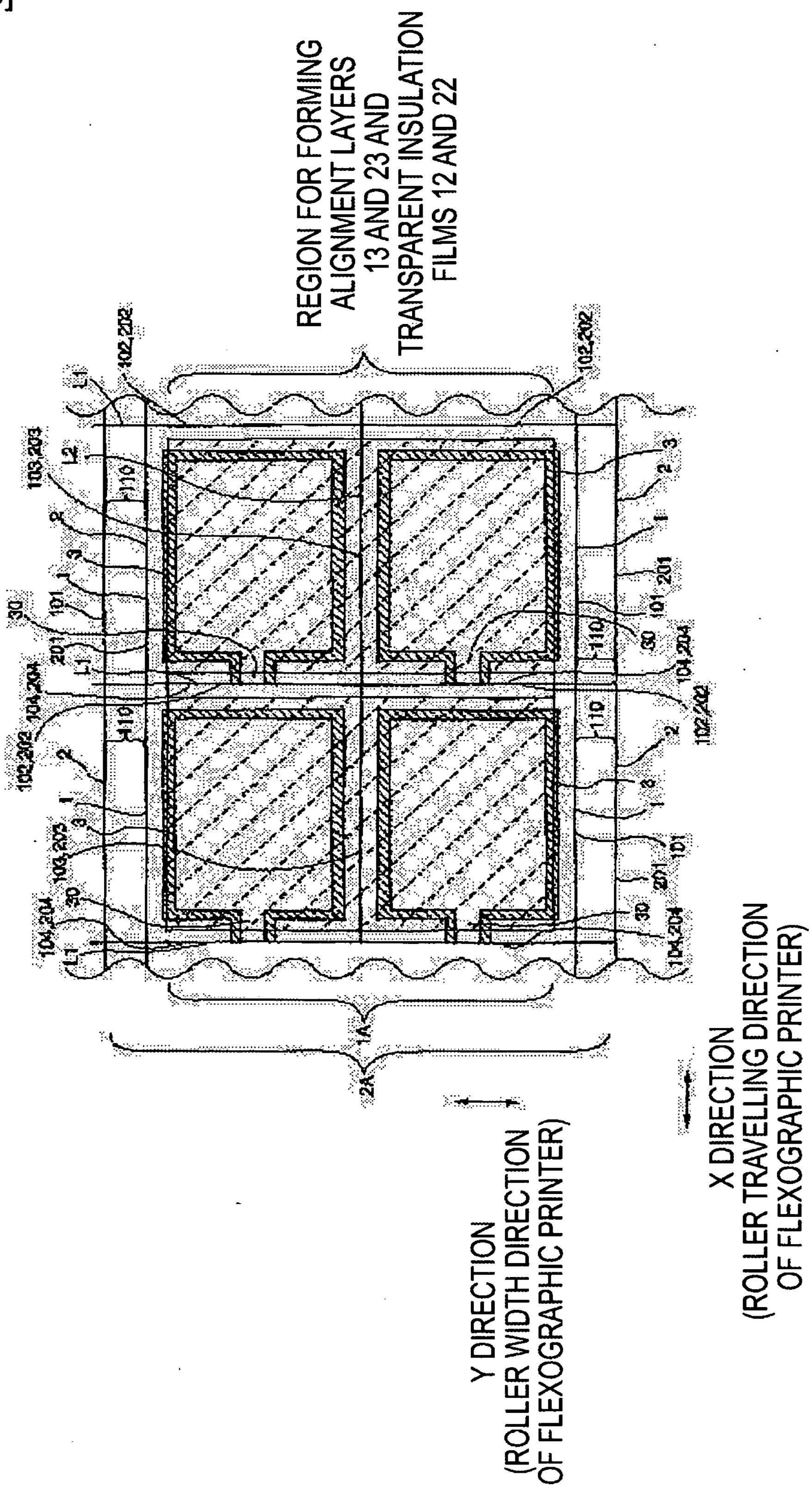
[FIG. 7]


REGION FOR FORMING ALIGNMENT LAYERS 13 AND 23 AND TRANSPARENT INSULATION FILMS 12 AND 22
1A
2A
Y DIRECTION (ROLLER WIDTH DIRECTION OF FLEXOGRAPHIC PRINTER)
X DIRECTION (ROLLER TRAVELLING DIRECTION OF FLEXOGRAPHIC PRINTER)

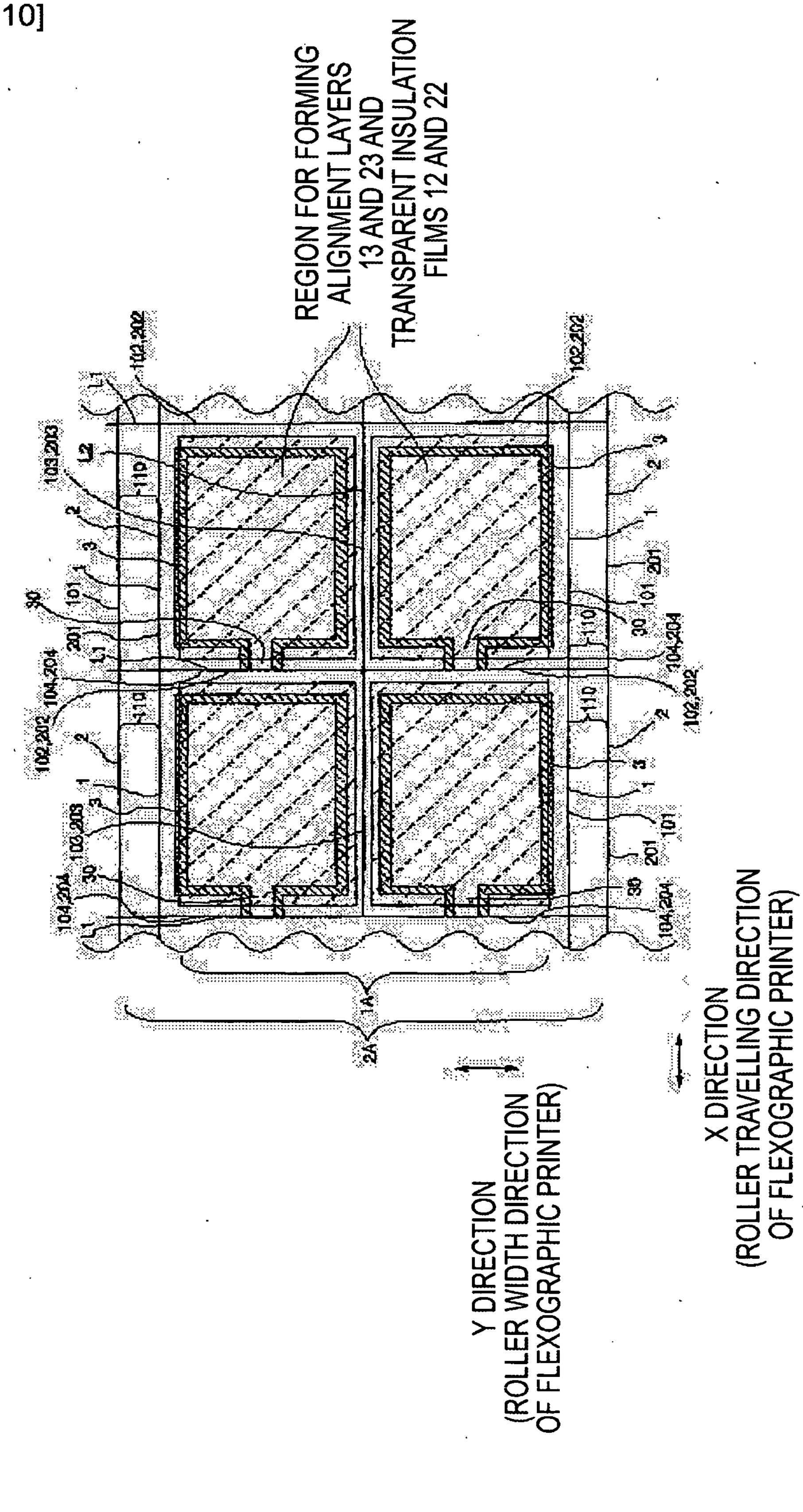
[FIG. 8]


REGION FOR FORMING ALIGNMENT LAYERS 13 AND 23 AND TRANSPARENT INSULATION FILMS 12 AND 22
1A
2A
Y DIRECTION (ROLLER WIDTH DIRECTION OF FLEXOGRAPHIC PRINTER)
X DIRECTION (ROLLER TRAVELLING DIRECTION OF FLEXOGRAPHIC PRINTER)

[FIG. 9]


REGION FOR FORMING ALIGNMENT LAYERS 13 AND 23 AND TRANSPARENT INSULATION FILMS 12 AND 22
1A
2A
Y DIRECTION (ROLLER WIDTH DIRECTION OF FLEXOGRAPHIC PRINTER)
X DIRECTION (ROLLER TRAVELLING DIRECTION OF FLEXOGRAPHIC PRINTER)

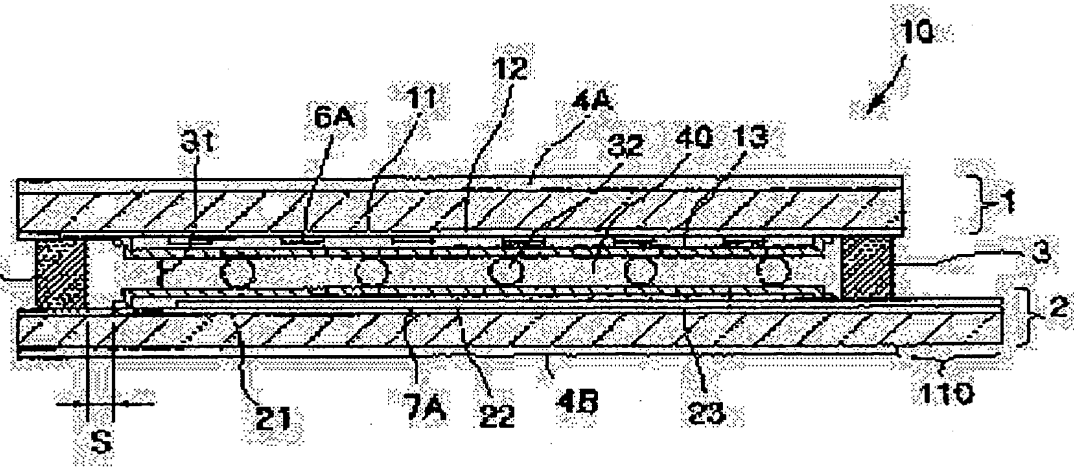
[FIG. 10]



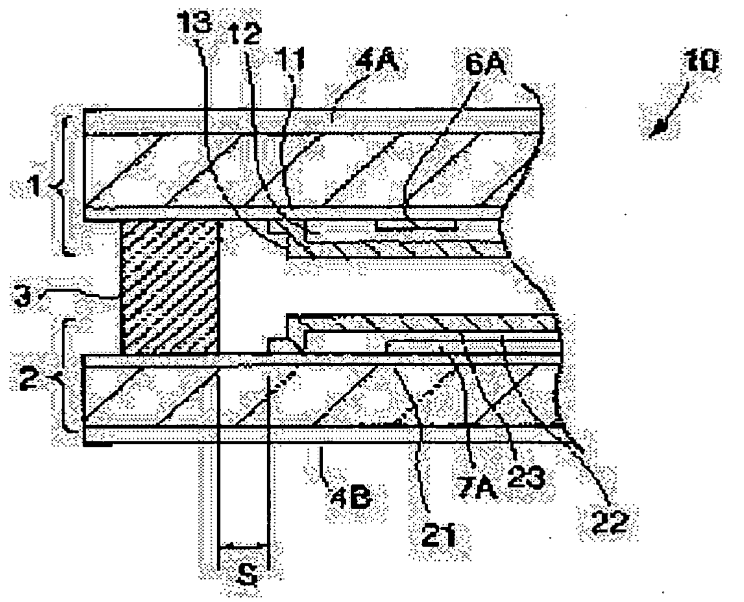
REGION FOR FORMING ALIGNMENT LAYERS 13 AND 23 AND TRANSPARENT INSULATION FILMS 12 AND 22
Y DIRECTION (ROLLER WIDTH DIRECTION OF FLEXOGRAPHIC PRINTER)
X DIRECTION (ROLLER TRAVELLING DIRECTION OF FLEXOGRAPHIC PRINTER)
1A
2A

[FIG. 11]

(A)


10
12
4A
6A
11
31
32
40
13
1
3
3
2
21
7A
22
4B
23
110
S

(B)


13
12
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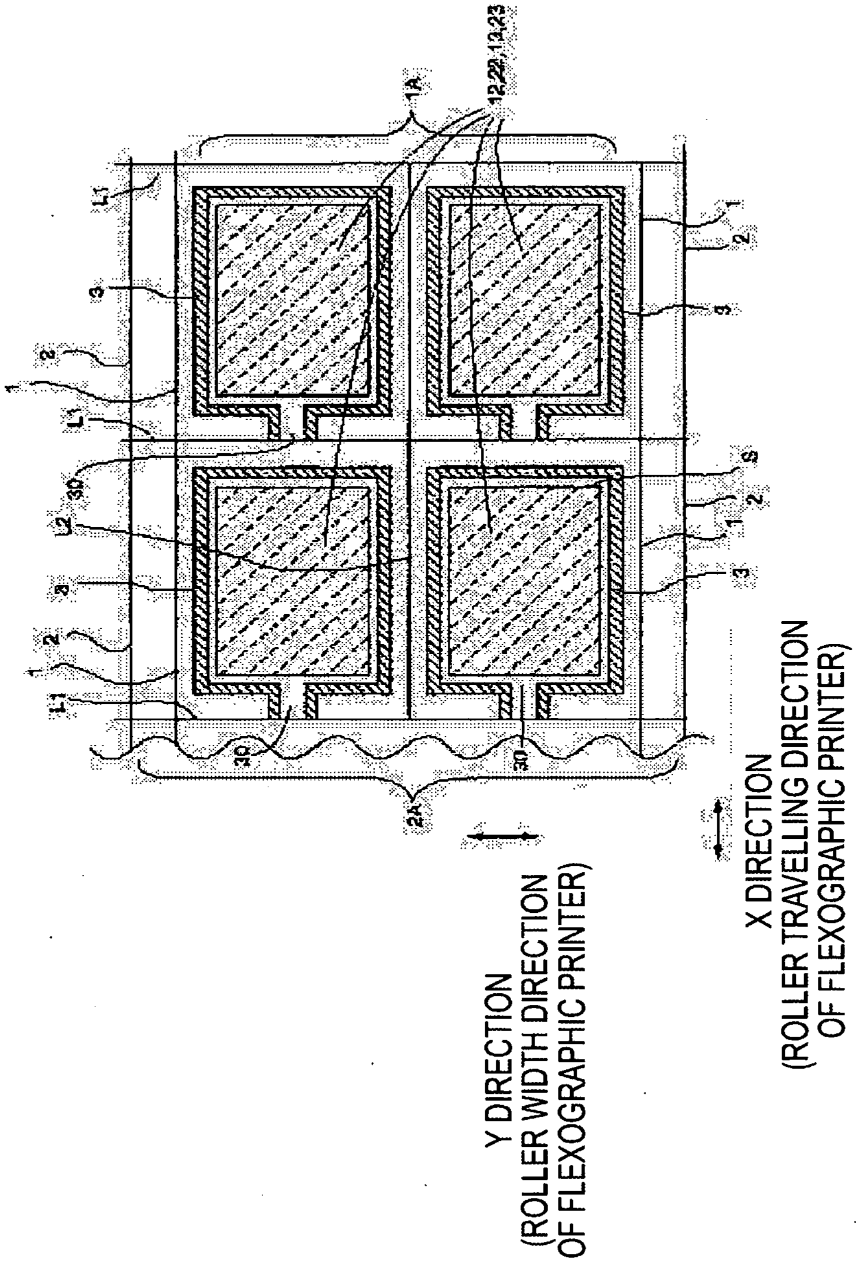
6A
10
1
3
2
4B
21
7A
23
22
S

[FIG. 12]


12,22,13,23
1A
L1
L2
S
1
2
3
30
2A
Y DIRECTION
(ROLLER WIDTH DIRECTION
OF FLEXOGRAPHIC PRINTER)
X DIRECTION
(ROLLER TRAVELLING DIRECTION
OF FLEXOGRAPHIC PRINTER)

[Name of Document] ABSTRACT

[Abstract]

[Object] To provide a liquid crystal panel in which the region for displaying images can be enlarged by preventing low twist domains from occurring in the space region between a sealant and alignment layers, and a method for fabricating the liquid crystal panel.

[Solving Means] In a liquid crystal panel 1 provided with first and second substrates 1 and 2 bonded by a sealant 3, alignment layers 13 and 23 for covering electrodes 6A and 7A, respectively, are formed up to the regions overlapping the regions for forming the sealant 3. Accordingly, since there is no space between the alignment layer 13 or 23 and the sealant 3, low twist domains do not occur in a liquid crystal 40. Therefore, the vicinity of the inner periphery of the sealant 3 can also be effectively used as the region for displaying images.

[Selected Figure] Fig. 5